FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION – 2025
FOR RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT

Chemistry Paper-I

TIME ALLOWED: THREE HOURS	PART-I (MCQS)	MAXIMUM MARKS = 20
PART-I(MCQS): MAXIMUM 30 MINUTES	PART-II	MAXIMUM MARKS = 80

NOTE:

    (i) First attempted **Part-I (MCQS)** on the separate **OMR Answer Book** which shall be taken back after 30 minutes**.**

    (ii) Overwriting/cutting of the **options/answers** will not be given credit.

    (iii) There is no **negative marking**. All **MCQs** must be attempted.

PART-I (MCQs) (COMPULSORY)

Q.1   **(i)** Select the best option/answer and fill in the appropriate Box on the **OMR Answer Sheet. (20 × 1 = 20)**
      (ii) Answers given anywhere else, other than OMR Answer Sheet, will not be considered.

1. Which of the following does *not* have the ground-state configuration $1s^2\ 2s^2\ 2p^6$?
(A) Ne
(B) Na
(C) Cl
(D) None of these

2. A reaction is exothermic if:
(A) $\Delta H > 0$
(B) $\Delta H < 0$
(C) $\Delta G > 0$
(D) $\Delta G < 0$

3. In chemometrics, multivariate calibration involves:
(A) Using multiple independent variables to predict dependent variables
(B) Using regression only on X-data
(C) Performing correlation without regression
(D) None of these

4. Langmuir isotherm assumes:
(A) Multilayer adsorption
(B) Uniform surface without interactions between adsorbed molecules
(C) Monolayer adsorption with interactions
(D) None of these

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5. A zero-order reaction rate does *not* depend on:
(A) Temperature
(B) Pressure
(C) Reactant concentration
(D) None of these

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6. Enzymes act as catalysts by:
(A) Increasing activation energy
(B) Lowering activation energy
(C) Changing equilibrium position
(D) None of these

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7. In an electrolytic cell:
(A) Electrons move from cathode to anode
(B) The anode is negative
(C) Energy is consumed to drive the reaction
(D) None of these

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8. Silicones are primarily:
(A) Organic polymers
(B) Inorganic polymers
(C) Hybrid organic-inorganic polymers
(D) None of these

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9. The Nernst equation relates electrode potential to:
(A) Pressure
(B) Temperature and concentration
(C) Surface area
(D) None of these

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10. In solvent extraction, distribution coefficient is:
(A) Ratio of solute concentration in two phases
(B) Ratio of solvents used
(C) Ratio of extractant to sample volume
(D) None of these

11. In gas chromatography, the mobile phase is:
(A) Liquid
(B) Gas
(C) Solid
(D) None of these

12. Solubility of a salt is decreased in presence of:
(A) Common ion
(B) High temperature
(C) High pH
(D) None of these

13. The solubility of a gas in a liquid is directly proportional to the partial pressure of the gas above the liquid. This is based on:
(A) Raoult's law
(B) Henry's law
(C) Kohlrausch's law
(D) None of these

14. The heat capacity of a calorimeter is determined using:
(A) A bomb calorimeter
(B) A known standard material
(C) Adiabatic temperature rise
(D) None of these

15. Fugacity is used to measure:
(A) Real gas behavior
(B) Ideal gas compressibility
(C) Equilibrium constant
(D) None of these

16. Lattice enthalpy is always:
(A) Positive and represents energy absorption
(B) Positive and represents energy release
(C) Negative and represents energy absorption
(D) Negative and represents energy release

17. According to Hess's law:
(A) Enthalpy change depends on reaction pathway

(B) Enthalpy change is path independent
(C) Enthalpy depends on final state only
(D) Enthalpy change includes entropy changes

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18. Debye-Hückel theory is used to calculate:
(A) Solubility of salts
(B) Ionic strength of solutions
(C) Gibbs free energy of ions
(D) None of these

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19. Potentiometric titration involves measurement of:
(A) Current in the reaction
(B) Volume at equivalence
(C) Electrode potential as a function of titrant added
(D) None of these

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20. According to molecular orbital theory, the bond order of O_2 is:
(A) 1.0
(B) 1.5
(C) 2.5
(D) None of these

PART-II

NOTE:
    (i) Part-II is to be attempted on the separate **Answer Book.**
    (ii) Attempt **ONLY FOUR** questions from **PART-II. ALL** questions carry **EQUAL** marks.
    (iii) All the parts (if any) of each Question must be attempted at one place instead of at different
        places.
    (iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.
    (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book
        must be crossed.
    (vi) Extra attempt of any question or any part of the question will not be considered.

Q. 2. **(a)** Define adsorption and explain its types. Derive an expression for the Langmuir **(08)**
adsorption isotherm and discuss factors influencing adsorption on solids.
    (b) Why are transition metal complexes often colored? Explain using crystal field **(07)**
theory with an example.
    (c) Compare and contrast the Lewis concept and the Bronsted-Lowry theory of acids and **(05) (20)**
bases. Include relevant examples and limitations.

Q.3. **(a)** What is laathanide contraction? Analyze its impact on the atomic radii and **(08)**
chemical properties of lanthanides and post-lanthanides.

	(b)	Analyze the quantum numbers associated with atomic orbitals and describe their importance in explaining electron configurations.	**(07)**
	(c)	Describe the catalytic activity of transition metals with reference to their variable oxidation states. Support your explanation with one example.	**(05) (20)**

Q.4. **(a)** Derive the Gibbs free energy equation from the first and second laws of thermodynamics and discuss its importance in predicting the spontaneity of chemical reactions. **(10)**

(b) Explain the principle of fractional distillation. Compare it with simple distillation using a diagram and examples of their applications. **(05)**

(c) Adsorption isotherms fail at high pressure. Why? Explain with reference to the limitations of the Freundlich isotherm. **(05) (20)**

Q.5. **(a)** Why are Lewis acids and bases more versatile in their applications than Bronsted-Lowry acids and bases? Provide two examples to support your answer. **(10)**

(b) Derive the integrated rate law for a first-order reaction and explain why the half-life of such a reaction is independent of its initial concentration. **(05)**

(c) State and explain the Heisenberg Uncertainty Principle. How does it limit our ability to precisely determine the position and momentum of particles? **(05) (20)**

Q. 6. **(a)** Discuss the Freundlich adsorption isotherm. Derive the equation and highlight its limitations. **(07)**

(b) Using a diagram, explain the principle and working of a galvanic cell. Discuss its components with the example of a Zn-Cu system. **(07)**

(c) Why does an exothermic reaction sometimes become non-spontaneous at high temperatures? **(06) (20)**

Q. 7. **(a)** Explain the relationship between entropy, enthalpy, and Gibbs free energy. Derive an expression for equilibrium using these thermodynamic quantities. **(08)**

(b) Derive the first law of thermodynamics and explain its connection with internal energy and enthalpy. **(07)**

(c) Define the concept of activation energy and illustrate its significance in reaction (05) (20) kinetics using the Arrhenius equation.

Q. 8. Define the following: **(5 each) (20)**
(a) Difference between Homogenous and Heterogenous Catalysis
(b) Define Molecular Orbital Theory (MOT)
(c) Difference between ANOVA and Gaussian Distribution
(d) Define Chromatography and write key differences between Paper Chromatography and Gas Chromatography